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Electricity market opening impact on investments in electricity sector

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ABSTRACT

The paper focuses on the impact of the electricity market regulation on generating technologies, including renewable in Lithuanian and Poland. The paper aims to identify how the regulatory and non-regulatory factors have influenced investors′ choices. A country case studies approach were applied to analyse and address define the main factors that have influenced investors′ choice of technology mix in electricity market in transition. The major findings of the analysis entail: the main driving forces behind the rationale for reform; electricity reform characteristics; the impact of electricity market reform on electricity prices and electricity market reform and non-reform related factors that have influenced investor′s choice for a specific generation technology or a technology mix.

Contents

1. Introduction

The opening of national markets in gas and electricity to competition visibly gives consumers the freedom to choose their energy supplier and, therefore, the opportunity to make savings. It also improves the security of supply by encouraging, on the one hand, investment in facilities, so that interruptions to supply can be prevented, and, on the other hand, diversification of transport routes and energy sources. The existence of a truly competitive energy market also contributes to sustainable development, notably by enabling suppliers of electricity from renewable energy sources to enter the market. The internal energy market has been put in place gradually, starting with Directive 96/92/EC laying

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down rules for the internal market in electricity and Directive 98/30/EC laying down rules for the internal market in natural gas, which were replaced respectively by Directives 2003/54/EC and 2003/55/EC. In 2007 the Commission announced that a third legislative package will be added to the available legislation. In the third package of legislative proposals for Europe′s electricity and gas markets, the Commission proposed measures which aim to benefit every single EU citizen by given consumers greater choice, fairer prices, cleaner energy and security of supply. Member States have to implement Third package until 3 March 2011. The new EU member states have achieved similar stages of electricity market opening.

The Lithuanian electricity sector since 1997 has undergone a reform process away from the regulated system towards a market based system. There are 3 periods of electricity sector reform in Lithuania: 1997–2002; 2003–2009 and since 2010. The main reasons for electricity reform during these two periods were corporatization and commercialization. In third period since 2010 the main objectives of electricity sector reform are based on EU Third energy package requirements, that aims to create competitive electricity market and to ensure fair competition; to ensure and promote the effective electric energy generation; to ensure the constancy and reliability of electric energy generation, transmission and distribution; to promote the development of internal electricity market and electricity export, modernization of infrastructure of market implementation, energy pricing clarity and transparency; to impose public service obligations which may relate to security of society, environmental protection and generating installations using local, renewable and secondary energy; to create favourable conditions for investments in the electricity sector; to promote environment friendly technology [1–4].

The reform in the Polish energy sector has been performed within the overall market oriented economy transformation. There are three periods of electricity sector reform in Poland: 1990–1997; 1997–2004 and since 2004. The main goal was the adjustment of electricity prices to the costs of service through introducing regulation by an independent regulatory body and competition wherever possible and feasible as well as by commercialization and privatization of state owned enterprises. Under the centrally planned economy electricity prices were being set politically by the government at the uniform level throughout the country. In the beginning of the reform in 1990 the introduction of market mechanisms caused substantial changes of the structure of the sector, including: unbundling of vertically integrated power companies; establishing the energy regulator; licencing procedure; and tariffs based on justified costs and consumers′ protection against socially unacceptable price growth [5,6].

However it important to assess if the aims of electricity market reform have been achieved and how electricity market liberalization impacts investments in new technologies. The main target of the paper is to identify how the regulatory and non-regulatory factors have influenced investors′ choices. The main aims of the paper to achieve target are: to review stages of electricity market reform in Lithuania and Poland; to review regulator arrangements, risk allocation and electricity prices in Lithuania and Poland; to assess impact of electricity market opening on investments in electricity sector.

2. Electricity market reform

In the past, the electricity industry has been organized as vertically integrated monopolies that were sometimes also state owned. The growing ideological and political disaffection about vertically integrated monopolies and the liberalization successes in other network industries have led to liberalization initiatives worldwide in the electricity industry. In EU Vertically integrated utilities have been vertically separated or unbundled and barriers to entry in generation and supply are being removed to create competition, seen as a vehicle to increase the competitiveness of the electricity industry.

Electricity market—means the entirety of relations between market participants encompassing wholesale and retail sale of electricity, based on justice and equality principles, in accordance with the principle of third party participation in the regulation of electricity distribution. The essence of electricity market lies in the possibility for consumers to choose the electricity supplier and electricity price. Electricity market creates competition, therefore electricity suppliers are able to purchase electricity from electricity producers at a lower price, whereas the users—from the suppliers offering an acceptable price. It is composed of two segments: retail and wholesale market. Wholesale electricity market is where electricity producers and suppliers take place. Competing between each other producers establish conditions for electricity suppliers to purchase electricity at as favourable conditions as possible. Retail electricity market is the market for suppliers and consumers. Competition takes place between electricity suppliers; consumers are able to choose a supplier according to electricity price, payment terms, etc.

2.1. Lithuania

Lithuanian electricity sector undergone during 20 years since restoration of independence dramatic changes from vertically integrated monopoly to power exchange. The stages of electricity market development in Lithuania:

- 1997—restructuring of vertically integrated monopoly “Lithuanian power” by separating centralized heat supply form electricity sector. Independent regulator was established.
- 2002—Law on Electricity and “Lithuanian power” was split into several independent companies: Lithuanian power (exporting electricity) with TSO and MO functions (Kruonis HPP, Kaunas HPP), two distribution system operators and several generation companies. One distribution company was privatized. Competition in generation and supply. Licenses were granted for several independent suppliers and two public suppliers.
- 2004—Law on electricity was amended according EU Second energy package. Full market opening was envisaged for the commercial consumers since 2004 and for all consumers since 2007 [7]. However because of Ignalina NPP dominating on the market and significant share of supported generation (CHP, renewables) the eligible consumers did not change their supplier.
- 2008—Holding company LEO.LT (61.7% shares of LR and the rest JSC NDX Energija) was created for new NPP construction. The subsidiaries of this company Lithuanian power company (TSO, MO, Kaunas HPP, Kruonis HPP) and two DSO companies [8].
- 2009—LEO LT was restructured again. The private DSO was bought by the Government back. The structure of electricity sector remain like before 2008.
- 2010—The Electricity law was amended to address EU Third energy package and Lithuanian power company was restructured by separating TSO (LITGRID) and Market Operator (BALTPOOL) activities into separate companies and also establishing JSC Energy Supply as independent energy supplier. Kruonis HPPS and Kaunas HPP are also separated. PEX.
- 2011—Visaginas NPP holding will be created the subsidiary of four units: Transmission: TSO LITGRID, Distribution: LESTO (two DSO were merged), Generation: Lithuanian PP, Kruonis HPP, Kaunas HPP, JSC Energy Supply, Energy Services: Technologies and Innovation center etc [9].

Before restructuring of the electric energy sector in 2002, the Special Purpose JSC Lithuanian power operated as a vertically integrated natural monopoly carrying out production, supply, transmission and distribution of the electricity in Lithuania. Electricity market structure and players in electricity market in 2002 are presented in Fig. 1.

In 2010 the Lithuanian electricity sector has undergone an important changes. Lithuania became a net importer country after closure of Ignalina NPP in the end of 2009. Wholesale and Retail electricity markets were further developed and AB Lietuvos Energija was restructured by separating TSO (LITGRID) and Market Operator (BALTPOOL) activities into separate companies and establishing JSC Energy Supply as independent energy supplier. The start up of Power Exchange from January 1, 2010 by applying the NordPool model. Regulated tariffs are removed for large consumers (consumption totalling 35% of Lithuanian demand). The main background for these changes was The European Union Third energy package entered into force on September 2009. Lithuanian electricity market expansion plan was adopted on July 2009 and Common Baltic Electricity market plan agreed among Baltic States on April 2009 and will be established by 2013.

The EU Third energy package requires: from 2011 at the latest the companies generating and supplying energy, will have to be unbundled from the companies owing or controlling the energy transportation system according unbundling model selected by particular MS; Full ownership unbundling; the independent system operator (ISO) model—vertically integrated companies may retain ownership of their network assets but the network is managed by ISO which is completely separate from vertically integrate company and performs all functions of SO; the independent transmission operator (ITO) model; compromise which preserves integrated supply and transmission companies but requires such companies to ensure that two activities: supply and transmission are operated independently.

As of January 2010 the Lithuanian market is based on the same principles as the Nordic power market (for wholesale trade organization), where price and flow are calculated at the same time to increase market efficiency (implicit auction). Electricity market structure and new players in electricity market are presented in Fig. 2 and described below.

The main players at Lithuanian electricity market since 2010: JSC Litgrid and JSC Baltpool. JSC Litgrid, is the electricity transmission system operator. The company performs electricity planning, dispatch control and operational planning. JSC Baltpool, as established to function as the electricity market operator. JSC Baltpool organizes wholesale electricity trade in Lithuania. Legal acts to regulate the activities of the electricity exchange were enforced and the NPS trading platform was successfully adapted to the Lithuanian electricity exchange. The company was established in compliance with the Electricity Market Development Plan approved by the Government of the Republic of Lithuania on July 8, 2009, with the aim to implement measures for the creation of a common electricity market of the Baltic States following the principles and experience of the electricity market (Nord Pool) of the Nordic countries [10].

From 1 January 2010 price formation principle—marginal price setting. Hourly trading and balancing responsibility applied for all market participants. Product: hourly energy quantity; Period: 24 h day-ahead; Trading arrangements: intersection of supply and demand curves, which is represented by the last supply bid matching demand bid; Cross-border capacity allocation: implicit auction—capacity and energy is traded simultaneously; Trading days: all year days; Bidding arrangements: specialized electronic trading platform provided by Nord Pool is in operation, where participants place their bids; Currency: Litas; Price settlement: announcement until 14:30 LT time.

Before 2002 the Lithuanian electricity sector could be described as a single vertically integrated monopoly JSC “Lithuanian power” and the State Enterprise Ignalina Nuclear Power Plant as the largest electricity producer, both owned by the state. As of 2010 the Electricity law was amended to address EU Third energy package and JSC “Lithuanian power” was restructured by separating TSO (LITGRID) and Market Operator (BALTPOOL) activities into separate companies and also establishing JSC Energy Supply as independent energy supplier. Kruonis HPPS and Kaunas HPP are also separated. Start up of Power Exchange from January 1, 2010. As of December 31, 2009, the JSC “Lithuanian Power” has six wholly owned subsidiaries: Energetikos Pajegos UAB, Kauno Energetikos Remontas UAB, Kruonio Investicijos UAB, Litgrid UAB, Energijos Tiekimas UAB, InterLinks UAB and Vsl Respublikinis energetiku mokymo centras. Indirectly, through Kauno Energetikos Remontas UAB, the Company has majority of votes in Gotlitas UAB, and through Litgrid UAB, it has a majority holding in Baltpool UAB [11–14].

2.2. Poland

Before the liberalisation began, the energy sector was not divided into the three segments of generation, transmission and

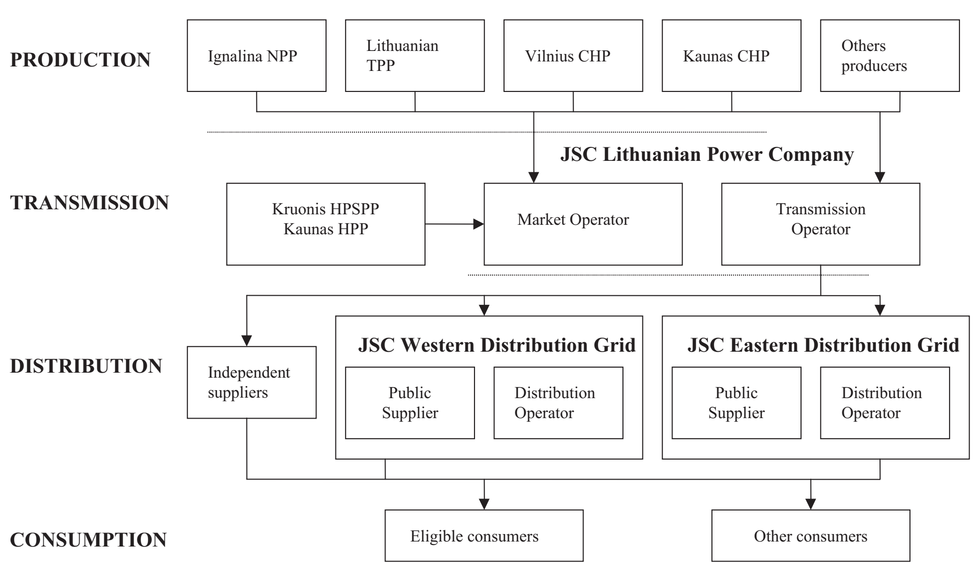


Fig. 1. Players in electricity market in 2002 in Lithuania.

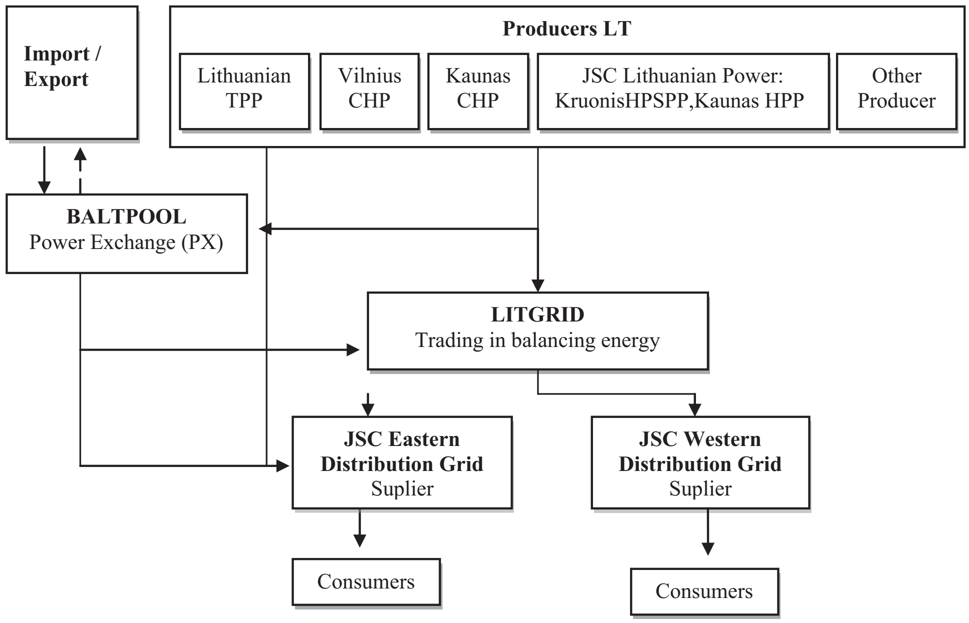


Fig. 2. Electricity market model in Lithuania, from 01 January 2010.

distribution. In Poland there was only one vertically integrated power company named "Wspólnota Energetyki i Węgla Brunatnego" (The Community of Power Industry and Lignite Coal), owning generating assets producing electricity, transmitted by grids belonging to these enterprises, and selling the energy to all customers [15]. Before 1990, the Polish electricity industry was organized in five vertically integrated regional utilities.

The stages of electricity market development in Poland:

- 1990—restructuring of vertically integrated monopoly. The Community of Power Industry and Lignite Coal; The Polish Power Grid Company was established; the distribution companies were corporatized in 1993, generation—in 1994;
- 1997—the Energy Law;
- 2000—the Polish Power Exchange (POLPX) started operation. The establishment of the daily/hourly balancing market, and simultaneously a gradual limiting of the sales of energy within long-term contracts, had a positive impact on the development of different forms of energy trading;
- 2004—law on electricity was amended according EU Second energy package. Full market opening was envisaged for the all consumers since 2007.
- 2005—the Council of Ministers adopted a governmental program document "Energy policy of Poland until 2025". Among the key principles are full integration of the Polish energy industry with European and global industries, fulfilment of the Accession Treaty obligations within the specified deadlines, the support of the development of renewable energy sources and of cogeneration sources, propagation of the idea of public–private partnership on the regional and local levels, consistent implementation of the principle of regulated TPA and granting access by transmission system operator (TSO) to transmission capacities of cross-border interconnections by way of auctions [16].
- 2007—the supply side was restructured in the spirit of the government's Programme for Electric Power Industry of 2006. In order to create a company capable of competing with other players on the European scale, PSE merged with two generating companies and eight distribution companies to form the Polish Energy Group.

Reforms in the Polish energy sector began with organizational changes instituted in 1990. In 1990, the regional utilities were broken up into 32 generation, one transmission, and 33 distribution enterprises. The Polish Power Grid Company was established as a Treasury joint stock company in 1990, while the distribution and generation companies were corporatized in 1993 and 1994, respectively. The electricity and coal-mining industries were officially separated. Generation, transmission and distribution of electricity became separate segments. The institutional framework for competition was established. The main goal of the energy sector transformation, were the introduction of competition and the improvement of efficiencies of electricity companies. These purposes were to be achieved by the division of the energy sector [15].

After 1990, Poland (like the other countries of the Visegrad Group—Hungary, Czechia and Slovakia) started to liberalise its economy. As a first step in the electricity sector, unbundling started as soon as 1990, while further steps (like privatisation or market opening for foreign capital) were not introduced before 1997–1999 [17]. The regulatory framework for the Polish energy sector was defined in the Energy Law Act. In 1997 the Polish parliament passed the Energy Law, with the stated aim of providing energy security, rationalizing the use of fuels and energy, promoting competition, counteracting the negative effect of monopolies, protecting the environment and ensuring consumer choice. The Law unbundled ownership of the electricity sector from regulation and policymaking—placing responsibility for energy policy development with the Ministry of Economy, ownership (including responsibility for privatisation) placed with the Ministry of Treasury, and the newly created Energy Regulatory Office (ERO) was given responsibility for regulation and ensuring competition develops [18]. The Energy Law changed the structure of the energy market.

It established the base for third party access, independent power producers, renewable energy sources (RES) and mechanisms for rational and efficient energy use (like least cost planning, integrated resource planning, demand side management, energy efficiency labels) [19]; it established the Energy Regulatory Office to issue licenses for generation, transmission and distribution, to define quality measures and approval and control of prices;

foreign capital was allowed to enter the market, and privatisation of electricity companies became possible [20].

The Law also enabled creation of the Polish Power Exchange (POLPX), a voluntary power pool and futures exchange and a few insignificant independent power exchanges. The POLPX started operation in 2000 as a voluntary pool market, similar to the Nordpool model.

In 2004 Poland joined the EU and had to comply with its regulations. In January 2005 the Polish government passed an amendment to the Energy Law implementing the EU′s Directives into the national legislation and paving the way for a competitive market [15]. Basic competition mechanisms were introduced and had to be spread over several years to implement all provisions of energy policy and relevant EU directives. At present the electricity market in Poland consists of three segments: bilateral contracts between the sellers (producers or trading companies) and consumers; transactions on the energy commodity exchange and on electricity trading platforms; and balancing market, managed by the transmission system operator.

The key objective of the balancing market (BM) is the on-line balancing of supply and demand of electricity and managing of congestions to ensure the required quality parameters in electricity supply. Minimisation of the cost of covering the demand on market principles across the whole system is a criterion of the functioning of BM. On the balancing market the TSO modifies the electricity supply schedules through increasing or decreasing generation of centrally dispatched units according to incremental or reduction bids. The Power Purchase Agreement that comprised about 70% of the electricity sales were dissolved due to European Commission requirement. The picture below shows the evolution of the Polish electric market in a schematic way [5] (Fig. 3).

The main participants in the Polish power markets are: transmission system operator (TSO), the PSE-Operator, the Polish Power Grid is the Operator; Distribution System Operators (DSO), that provide grid transport services through distribution network to all other market participants (14 grid companies); electricity generating companies that sell electricity to the grid and to the customers in the four capitals (PGE, Tauron, Enea and Energa); and electricity trading companies. Majority of Polish power capital groups are quoted on the Stock Exchange with the ownership domination of the State treasury. The State Treasury owns 100% of stakes of PSE Operator and over 50% stakes in the rest of the energy capital groups: PGE share of State Treasury in the ownership mix 70%, Tauron—60%, Enea—52%, Energa—51% [5,21,22].

3. Regulatory arrangements

Regulatory arrangements play important role in attracting investments in renewables and other generating capacities therefore the impact of regulatory arrangements in Lithuania and Poland on investment choices will be analysed in the following sections.

3.1. Lithuania

In the process of the electricity market liberalization in Lithuania the Government has gradually withdrawn from electricity sector regulation by transferring these functions to independent institution. The price setting principles and the prices themselves, entry to the market (licensing), promotion and supervision of competition, defence of customer rights—these and other functions were passed over to the National Control Commission for Prices and Energy (NCCPE) established in 1997 which were not subordinate to the Government.

In the process of harmonisation of the legal acts in the sector of energy with the provisions of the European Union directives relating to electricity the NCCPE that was previously responsible for pricing, price setting and their application evolved into a commission that has undertaken the actual economic regulation of energy sector [23]. The NCCPE sets long-term basic prices for heat utilities, issues licenses and supervises their operations, coordinates investments, and resolves disputes.

The responsibilities of NCCPE include tariff setting, licensing, monitoring of supply service quality and dispute resolution. The Lithuanian power system at present consists of thermal, hydro and renewables energy generation (Tables 4 and 5). With the closure of the nuclear power plant Lithuania is very vulnerable to any interruptions of the Russian fuel supplies as all natural gas and crude oil supplies are coming from Russia only and almost all electricity generation in the country is based on oil and gas.

Pursuant to Article 40 of the Law on Electricity of the Republic of Lithuania [24] national electricity market shall be established gradually providing third party access to eligible customers and the right to conclude direct power supply contracts with freely

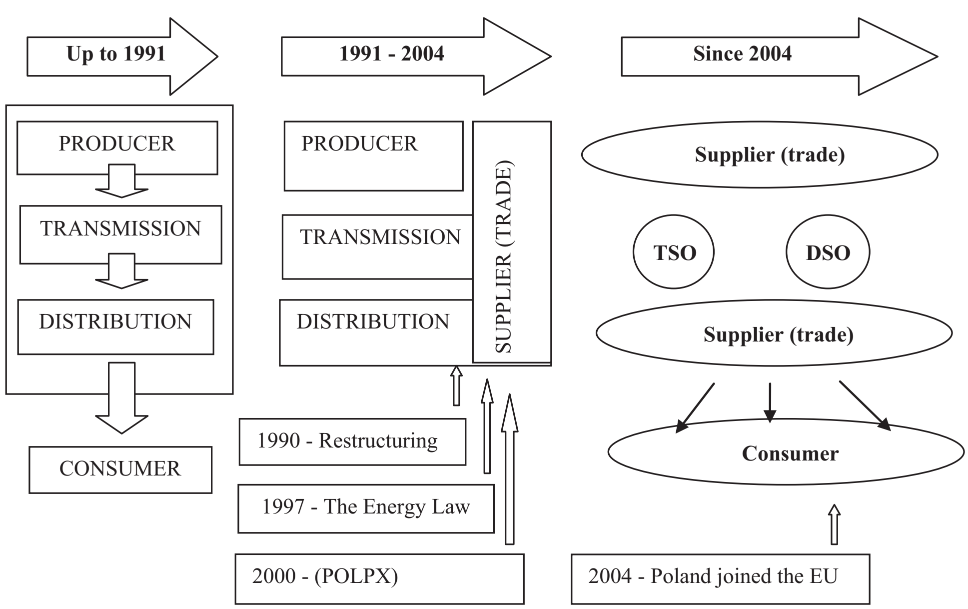


Fig. 3. Electricity market reform in Poland.

selected independent suppliers. Under the Regulated Third Party Access (rTPA) market structure, the transmission company publishes transmission tariff and access requirements so that generators may enter into agreement with the eligible customers. The eligible customers can directly negotiate with the generators. Under this alternative, the remaining customers are charged a cost-based rate by the regulator based on presumably optimal operation. Under the rTPA, the regulator observuos the merits of the resources, such as hydro, thermal, and IPPs under very tight regulation. In addition to the regulated market, a spot market may also be created for real-time operation with marginal cost pricing. With this model, competition is created to some extent at the generation level (despite tight regulation) and at the retail level. The rTPA does not offer a level playing field due to lack of a central market, with transparent rules and a single price for all [5].

In Lithuania, electricity is traded by bilateral contracts (local contracts) or via Power Exchange. A bilateral contract is an agreement between an energy consumer and an energy supplier to buy and sell a specified quantity of energy at a specific price. All imported or exported energy is traded via Power Exchange. The average daily (or monthly) wholesale price of electricity at the Lithuanian power exchange is usually lower than the regulated price of electricity, but the price of electricity traded at peak times is more expensive. The Power Exchange has been operating for too short a period to track consistent tendencies or draw conclusions on the effect of participation in it.

3.2. Poland

The Polish electricity market is regulated by the Energy Regulatory Office (ERO). Its president is nominated by the Minister of Economy and regulates the activities of energy companies pursuant to the Energy Law Act of 1997, amended in 2005. The ERO is responsible for licensing, tariff setting, establishing quality of service standards, consumer protection, promoting competition and energy efficiency.

The regulation of the energy market in Poland is taking place on three levels:

- The Energy Law is the highest level; it contains essential principles of regulation as well as fundamental institutional solutions.
- The government directives to the Energy Law issued by Councils of Ministers, the Prime Minister and the Minister of the Economy.
- Regulations issued by the Chairman of ERO.

According to EU directives, member states can choose between three different systems of grid access: negotiated, regulated or single supplier. In Poland a sort of mixed negotiation–regulation approach was adopted. It imposes an obligation on the network companies to guarantee access on certain conditions, including technical and economic criteria, agreed by the parties. The ERO is responsible for regulating access charges and for settling disputes concerning access conditions in order to prevent access being blocking by distribution companies. The introduction of Third Party Access has not accelerated the liberalisation of the energy market.

A special role is fulfilled by the transmission system operator, which, via the grid code, creates duties and gives access rights to his services to market participants. Some parts of the grid code referring to balancing and congestion management are now analyzed by the Energy Regulatory Office. The most important issue is – according to the president of the ERO – to make sure that these regulations do not create new barriers against competition [15].

According to the Energy Law the transmission system operator (TSO) is responsible for secure and effective operation of the transmission grid, cooperation with other electricity system operators or power companies to ensure reliable and effective operations of power systems and coordinate their development, management of the outputs of generating units connected to the transmission grid, and balancing of the electricity system as well as management of system congestions. The distribution companies that are nominated as distribution system operators (DSOs) are responsible i.e. for effective operation of the distribution grid with the required reliability of electricity supply and quality of supply, maintenance and repair of grids, installations and equipment, ensuring long-term capacity of the distribution system to assure rendering distribution services in domestic and trans-boundary trade, cooperation with other electricity system operators or power companies dispatch of the generating units connected to their grids, balancing of the distribution system except for final balancing of the power system and congestion management [5,25].

4. Special incentives affecting generation choices

4.1. Lithuania

Special Lithuanian government incentives that affect the choice of generation:

- *Discount on the fee of connection of power plants to the network.* Generators whose power plants are using renewable energy sources for electricity generation are subject to a 40% discount for the connection to the network of operating energy plants.
- *Purchase obligation and transportation priority.* Pursuant to the Regulations holders of the electricity supply licence are obliged to purchase renewable electricity and sell it to their customers. The transmission network operator shall ensure transportation priority for the renewable electricity when the network throughput is limited.
- *Financial support for investments.* Financial support for investments is among the most important measures promoting the use of renewable energy sources (Lithuanian Environmental Investment Fund, EU Structural Funds).
- *Feed-in tariffs.* For wind power plants—30 LTL ct/kW h, biomass power plants—30 LT ct/kW h, hydropower plants (only for hydropower plants of the capacity less than 10 MW)—26 LT ct/kW h (from 1 January, 2009) [26].

Currently renewable energy makes up ~14% of energy produced and approximately ~5% of electricity produced in Lithuania. The usage of RES in Lithuania is constantly growing. The biggest renewable potential in producing electricity in Lithuania is found in the field of wind energy.

4.2. Poland

Polish government supports generation of energy from renewable sources. The Polish RES policy includes the following mechanisms:

- *Tradable certificates of origin* introduced by the April 2005 amendment of the Law on Energy (1997);
- *The obligation for power purchase from renewable sources* (2000, amended in 2003) involves a requirement on energy suppliers to provide a certain minimum share of RES (3.1% in 2005, 3.6% in 2006, 4.8% in 2007 and 7.5% in 2010). Failure to comply with this legislation leads – in theory – to the enforcement of a penalty;
- *An excise tax exemption* on RES was introduced in 2002;
- *Transportation priority.* The transmission network operator shall ensure transportation priority for the renewable electricity when the network throughput is limited.

Poland support mechanism is based on green certificates issued on the request of the generating entity, via the grid operator, by the President of the ERO. On one hand the certificate confirms that the electricity was generated in RES, and on the other hand the property rights resulting from the certificates are marketable and are an exchangeable commodity after recording them on the evidence e.g. by the Polish Power Exchange. Thus additional income from selling the certificates is provided for RES producers [27]. Each year, the ERO increases the substitution fee by the national inflation rate for the previous year. The value of the substitution fee, hence the reference value of the green certificates, has grown as follows: 59.8 EUR/MW h in 2008, 62.3 EUR/MW h in 2009, 64.5 EUR/MW h in 2010 and 66.2 EUR/MW h in 2011 [28]. In effect, the RES producer receives the wholesale price for electricity plus the price for the Certificate of Origin, which is determined on the market (usually at the POLPX power exchange).

Producers of energy from renewable sources may benefit from selling certificates of origin. Moreover, energy vendors are obliged under the law to purchase energy from RES. Green energy producers have priority access of to transmission network. Electric energy generated from RES is exempt from excise tax. The fee for grid connection for smaller installations (<5 MW) is reduced by 50%. Such installations are exempt from the license fee and the annual fees paid by the license holders. Investments in clean energy may be co-financed by EU funds, National Fund for Environmental Protection and Water Management and several Polish banks [29].

Pursuant to the decision (ordinance) of the Minister of Economy of 14th August 2008 on the green certificates, this share amounts to as follows: 8.7% for 2009; 10.4% for 2010; 10.4% for 2011; 10.4% for 2012; 10.9% for 2013; 11.4% for 2014; 11.9% for 2015; 12.4% for 2016; 12.9% for 2017 [27].

5. Energy prices

5.1. Lithuania

The NCCPE regulates the prices by setting price caps. The price caps are set for the three-year regulatory period. Price caps set by the NCCPE are subject to annual revision in the event of changes in the forecasting data of the sold or transported electricity volume, annual inflation rate, taxes payable by the service provider or other factors beyond the service provider′s control affecting price cap computation [30]. Over the last years the prices of electricity in Lithuania are increasing (Table 1).

The prices of electricity in Lithuanian PEX and Continental Europe electricity markets including Poland are quite similar. In 2012 January the average electricity prices in Lithuania PEX was 153.4 LT/MW h and in Poland –133.3 LT/MW h. In summer 2012 the prices of electricity were decreasing in both countries because of favorite weather conditions including wind speed and temperature.

In 2004 the Law on Electricity was amended in order to adjust it to the latest EC Electricity Directive: full market opening was envisaged for the commercial consumers since July 2004 and for the residential consumers—3 years later, from July 2007. At the same time the Regulator was obliged to monitor and supervise market ensuring fair, non-discriminatory access to the grid and transparent use of the grid capacities. Despite of the full market opening for all commercial consumers, number of the customers changing their supplier did not increase as only the largest consumers have done it.

Table 1
Electricity prices in Lithuania, €/kW h.
Source: [31].

2003	2004	2005	2006	2007	2008	2009	2010	2011
Electricity prices for household								
–	0.0535	0.0609	0.0609	0.0658	0.0729	0.0799	0.0955	0.1004
Electricity prices for industry								
0.0550	0.0513	0.0498	0.0498	0.0548	0.0829	0.0924	0.0991	0.1045

The Lithuanian power system consists of nuclear, thermal and hydro energy generation (Table 4). Lithuanian electricity market is too small; generators are too big, with different market power, especially because of the prevailing artificially low cost nuclear power plant covering 70% and more of the domestic electricity demand, so liquid electricity market is hardly possible. Even with the closure of the Ignalina NPP national electricity market in Lithuania will be hardly competitive. Concentration in the Lithuanian electricity market until 2005 was very high, and measured by the Hirschman–Herfindahl index (HHI) reached 5572 [32].

The risks of investment in generation are taken by the investors based on their expectations of future prices unless they can pass risk to others. They face the risk of losing money if they make the wrong decisions, but it balanced by the incentive of making greater rate of returns if their decisions are the good ones. The long term contracts may lead to reduction of uncertainty. In any case the rewards will balance the higher risks. Potential investors must be able to form rational expectations of future prices.

From 01 January 2010 Regulated tariffs are removed for large consumers (consumption totalling 35% of Lithuanian demand). From 01 January 2015 Regulated supply tariffs for all consumers shall be abolished except the guaranteed tariffs for the groups designated by EU regulations (Table 2).

5.2. Poland

The Regulator designs methodology to determine the justify level of regulated revenue of energy companies. That methodology provides guidelines for tariff calculation. Energy companies prepare tariffs including, among others, prices and charges, and then submit those tariffs for an approval to the President of ERO. However, the structure of the tariff prepared by the company depends on the type of company activity, and it is based on relevant legal provisions. In that respect, the role of regulatory body is to make sure that composition of the tariff is compliant with formal requirements [34].

Tariffs are set only for regulated activities. At present the regulated activities comprise all transmission and distribution grid related services and sales of electricity to households. The Energy Law requires that the tariffs should be based on justified costs of each regulated activity and should take into account protection of energy consumers against unreasonable energy prices. The tariffs should be shaped in a way that minimizes cross-subsidies. Special regulation prevails regarding renewables and cogeneration, as law obligates electricity suppliers to sell a specific amount of electricity produced from renewable and cogeneration [5,35]. Over the last years the prices of purchased electricity (energy prices) are increasing because of the necessity to finance the obligatory growing share of costly green electricity (Table 3).

6. Risk allocation

6.1. Lithuania

The physical electricity market or spot market is only one aspect of an electricity pool or exchange. In addition to the physical day-ahead markets, the financial markets play an important role in Lithuanian electricity market Contracts are signed

Table 2
Application of regulated tariffs in Lithuania.
Source: [33].

Starting from	Application of regulated tariffs
1st of January 2010	Regulated tariffs is going to be abolished for the consumption totaling 35% of Lithuanian demand (consumers with > 400 kW capacity)
1st of January 2011	Regulated tariffs is going to be abolished for the consumption totaling 45% of Lithuanian demand (consumers with > 100 kW capacity)
1st of January 2012	Regulated tariffs is going to be abolished for the consumption totaling 55% of Lithuanian demand (consumers with > 30 kW capacity)
1st of January 2013	Only household consumers shall fall under the regulated supply tariffs scheme
1st of January 2015	Regulated supply tariffs for all consumers shall be abolished except the guaranteed tariffs for the groups designated by EU regulations

Table 3
Electricity prices in Poland, €/kW h.
Source: [31].

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Electricity prices for household										
0.0710	0.0818	0.0775	0.0699	0.0823	0.0923	0.0945	0.0965	0.0883	0.1049	0.1145
Electricity prices for industry										
0.0492	0.0585	0.0566	0.0446	0.0506	0.0543	0.0541	0.0814	0.0857	0. .0929	0.0963

between the different market players wishing to protect themselves against fluctuations in the "spot electricity prices" or to allocate their risks to other parties. Only direct participants in the market – such as transmission or distribution systems operators, electricity suppliers, importers, exporters and producers – are allowed to trade. Consumers are not treated as direct participants in the wholesale market and accordingly they cannot buy electricity at the power exchange. To become a direct market participant in order to trade electricity on the Lithuanian power exchange, a company must acquire a supplier′s, transmission or distribution systems operator′s, importer′s, exporter′s or producer ′s license issued by authorized institutions. In addition, a contract must be made with a balance energy supplier on the sale or acquisition of balance electricity. Trading on the stock exchange is pursued under its regulations determining trade and clearing conditions, responsibility for the breach of rules, market conduct rules, ethical guidelines, payment schedules and trading fees; and under agreements, concluded between the participants and the power exchange operator. Trading on the Lithuanian power exchange is based on security of the payment among the participants of the electricity market, fair competition, reliability, fairness, equality and clear information principles.

6.2. Poland

Market related risk is allocated among all market players: the highest risk is born by electricity producers based on coal and lignite because of uncertainties of the level of the costs of CO_2 emission allowances; Investor′s financing the development of power plants based on coal or gas also bear the risk of the level of the costs of CO_2 emission allowances in the future and gas prices on the international market; and tax payers are also exposed to the ecological risk as all the costs related to growing ecological requirements finally are to be borne by final energy consumers who are pay ecological fees which may be treated as a kind of taxes [5]. Poland has been reducing greenhouse gas emissions for years. The main factor reducing the emissions consisted in reducing the use of primary energy in the national economy. At the same time, there has been a change in the structure of fuels used, consisting in the decrease of coal consumption and increase of the use of renewable energy sources. Nevertheless, from 1988 to 2009 there were periods when greenhouse gas emissions increased due to robust economic growth [36].

7. The impact of electricity market opening on investments

7.1. Lithuania

Until 2002 there was no investment in generating capacities in electricity sector of Lithuania because Lithuania has inherited from soviet past very huge overcapacities in power sector. Electricity generating capacities exceeded domestic demand more than three times. Besides that Ignalina NPP generated more than 80% of total electricity consumption in Lithuania [37]. The price of electricity produced at Ignalina NPP was significantly lower comparing with other generation sources (CHP or Lithuanian thermal power plant). There was no price incentives to develop renewable as well. The electricity prices were low and stable and significantly exceeded new entrant costs.

Up to 2010 the structure of electricity market did not have impact on electricity generation mix in Lithuania. The power exchange started in 2010 allows competition in electricity generation sector however the new investments in electricity generation capacities are mainly based on Feed-in tariffs for electricity produced from renewables as Lithuanian electricity market is small and isolated. The biggest electricity generation source—state owned Lithuanian thermal power plant is being subsided through public service obligation (PSO). The List of Public Service Obligations approved by the Government of the Republic of Lithuania for the purpose of implementation of the provisions of the Law on Electricity. Therefore just feed-in tariffs attracts new investments into renewable generation. As there are no possibilities to develop hydro power plants in Lithuania because of environmental legislations the main investments were into wind power plants. However the investments in wind generation is also limited because of the difficulties with the acquisition of permit to built wind power plant and various environmental requirements imposed by state for building new wind power plants.

The type of ownership up to know did not have the direct impact on the choice of electricity generation technology. There was no significant new investments in electricity generation sector until 2002. Since 2002 private generators were investing mostly in renewables. Public power producers were responsible for running Hydro power pumped storage and Lithuanian Thermal Power Plant for the purpose of maintaining system balance and other economic and social benefits related with security of supply. The construction of a 450 MW new combined cycle gas fired plant at

state owned Lithuanian Thermal Power plant net is underway and will be completed by the end of 2012.

The decision to built new nuclear power is also related Governmental policies. In 2007 Lithuanian parliament adopted new energy strategy which has set the target to built new nuclear power plant up to 2020 as additional renewable capacity will not provide the base load power supply required in the region. Nuclear investment allows Lithuania and the region to secure energy supply and meet commitments to low-carbon generation. In June 2007 the Lithuanian Parliament approved the Law on the Nuclear Power Plant. Purpose of which is to lay down provisions and to create legal, financial and organisational preconditions for the implementation of a new NPP project. At the beginning of December 2009, Lithuania announced an invitation for investment in the new Visaginas NPP project. The purpose of this tender is to attract to the Project financially strong investors who have experience in the nuclear energy sector. The negotiations with Regional partners (national utilities in nearby countries) and Strategic Investors as well as signing of agreements with them are to be finalized in 2011 [38]. The development timetable for the Project is aimed at achieving construction of a new NPP in time to start generating electricity between 2018/2020.

Network/access regulation has impact on investments in electricity generation technologies. The Law on Electricity sets forth that the NCCPE must control that network connection conditions and tariffs for new electricity producers are objective, transparent and non-discriminating taking into account all costs and benefit derived from renewable energy sources. If the transmission and distribution conductivity of networks is limited, the operators must ensure priority for transportation of electricity produced from renewable energy sources.

Provisions of Resolution No 1474 intended to implement the Law on Electricity set that public and independent suppliers, market, transmission and distribution network operators holding activity licences and eligible customers importing electricity shall provide services according to the list of public services obligation in the electricity sector. In addition power plants using renewable and waste energy resources are connected to the electricity grid according to the legislation with a discount of 40% of the interconnection fee for the producers.

There was no impact of electricity market structure on investments in energy sector because there was no real competition on the electricity market until 2010. There were no new generation capacities built since 1990 except small industrial CHP and renewables, mainly wind because of policy tools: Feed-in tariffs, Financial mechanisms, GHG emission trading scheme. In 2008 35 MW electric capacity gas-fired CHP was built in Panevezys. These investments were related not with electricity market structure but with development of district heat supply system in Panevezys city and closure of old not-efficient heat boiler which were using high sulphur fuel oil which use is prohibited by EU Sulphur and LCP Directives. Plans exist to build a few smaller CHP′s in Alytus (20 MW electric capacity and 30 MW thermal capacity), Marijampole (20 MW electric capacity and 30 MW thermal capacity), Panevezys (35 MW electric capacity and 33 MW thermal capacity), Utena (2 MW electric capacity and 8.5 MW thermal capacity), Siauliai (9 MW electric capacity and 20 MW thermal capacity). As there were no “clean” coal projects planned in Lithuania, the major planned CHP′s are gas-fired, with some small biomass-fired CHPs. Also in Vilnius (20 MW electric capacity and 50 MW thermal capacity), Kaunas (15 MW electric capacity and 50 MW thermal capacity) and Klaipeda (25 MW electric capacity and 50 MW thermal capacity) there are plans for waste incinerators. The first waste-to-energy plant will be built in 2013 in Klaipeda. The plant, which will use municipal and industrial waste and biomass as fuels, will have a capacity of about 50 MW heat and 20 MW electricity and will replace the natural gas fired heating plants of Klaipedos Energija. Construction of a new combined cycle unit with a capacity of 450 MW at the Lithuanian thermal power plant has been started in 2009 and it should be put into operation in 2012. This project is financed from Ignalina NPP closure fund.

Regulated electricity tariffs have impact on investments in electricity generation sector as the National Regulator (NCCPE) may send respective signals about the need for investments to the market players and apply required measures via pricing. Under the Law on Energy, energy undertakings engaged in activities with regulated prices have to approve planned investments with the NCCPE. If investments of such energy undertakings are not approved by the Regulator, they may not be recognized as justified for the purpose of revising state regulated prices. To retain diversity of energy sources the use of renewable ones is encouraged by increasing buying costs and by setting support for new energy sources, such as solar energy.

Investments are encouraged by calculating depreciation and normative profit based on the asset market value, and moreover, the normative profit margin and regulated activity assets have been set by the Law on Electricity. With the amendments to the Law on Electricity passed at the end of 2009 and with the Government′s approval of the valuation principles of assets used in the licensed activities in autumn 2009, the Electricity Transmission and Distribution Service Price and Price Cap Setting Methodology was modified accordingly. In 2010 electricity transmission and distribution service price caps were recalculated based on the un-revalued fixed tangible asset value. With respect to the set minimum power supply reliability and service quality indicators, in 2009 methodologies included rates of penalties and incentives to ensure the quality of investment use.

The electricity price in PEX have impact on investments in electricity generation technologies. Since PEX establishment the electricity price has reduction trend but the world energy resource prices are increasing. Therefore it is anticipated that market price for electricity will increase at levels potentially sufficient to attract investors for the new NPP. The ability to access a broad European energy market and a liberalised wholesale market connected to Nord Pool are key commercial drivers for the new NPP. In addition from 2016 existing and planned investments in power plants will not be able to meet the increased electricity demand in Baltic region.

Table 4
Development of generating capacities in Lithuania.
Sources: [1,7,26,37].

Power plant	Installed capacity, MW				
	1990	2001	2006	2010	2015
Nuclear	**3000**	**3000**	**1300**	–	–
Ignalina NPP	3000	3000	1300	–	–
Thermal	**2656**	**2649**	**2330**	**2380**	**2460**
Lithuanian PP (n. gas HFO)	1800	1800	1500	1500	1500
Vilnius CHP (n. gas, HFO)	384	384	380	370	370
Kaunas CHP (n. gas, HFO)	190	180	180	170	170
Mazeikiai CHP (HFO)	210	200	160	160	160
Other CHP (n. gas)	72	85	110	180	260
Hydro	**106.1**	**1015.8**	**1027**	**1030**	**1030**
Kruonis HPPS	–	900	900	900	900
Kaunas HPP	100	100	100	100	100
Other small HP	5.3	15	27	30	30
Other renewable	–	–	**69**	**115**	**340**
Other renewable (biomass)	–	–	20	25	40
Wind PP	–	–	49	90	300
Total	**5861**	**6665**	**4726**	**3525**	**3830**
Daily demand	4400	2000	1800	2370	2750

Regulatory institution (NCCPE) procedures such as licencing, monitoring and other regulatory arrangements have direct impact on investments in generation technologies. NCCPE was established as an independent institution in 1997 however based on the aforementioned discussion, it appears that the regulator's independence does not have a direct influence on the attractiveness of investment climate of the electricity industry as there were no investments in electricity sector up to 2008.

NCCP investigates consumers complains as pre-trial institution. NCCP investigate complains according the rules set for investigation of complains and another questions. The decisions of NCCPE are compulsory. This dispute resolution approach does not have direct impact on investments in electricity sector. According Licensing Rules in Electricity Sector licenses there are several types of licenses: electricity transmission; electricity distribution; electricity public supplier; electricity independent supplier; electricity market operator and a separate licence shall be issued for each type of activity. Licences shall be issued by the NCCPE. A new Energy Company Technological, Financial and Management Capacity Assessment Procedure were developed in 2009. Based on this Procedure nine new relative financial indicators shall be calculated: four of them are revenue protection indicators, four others – financial leverage, and one – commercial activity indicator. The above indicators shall be used as the basis to calculate the company financial capacity indicator which shall be compared with limit values of the normative indicator of the gas sector. The company financial capacity shall be rated sufficient for performing licensed activities, if its total financial capacity indicator (within the last two years) exceeds the NCCPE set bottom threshold for the normative indicator of the sector. This requirement has some impact on investments and choice of electricity generation technologies.

There are several monitoring and compliance procedures established in Licensing Rules. The enterprise engaged in the activities of the electricity market operator, electricity transmission activities, electricity distribution activities, electricity public supply activities and electricity independent supply activities must prepare and agree with the Commission the procedure for registering and investigating customer complaints or requests and taking decisions; at the close of the year, conduct an analysis of complaint investigation and submit a report on complaint investigation to the Commission; conduct an annual analysis of the operation of electricity transmission and electricity distribution systems, electricity supply to customers (electricity market) and provide the Ministry of Economy and the Commission with information about development prospects for electricity transmission and distribution systems and the electricity market.

NCCPE regulates transmission and distribution, end-users tariffs and other important issues having direct impact on investments in electricity generation sector. For example, for larger cogeneration systems the NCCPE defines quotas for electricity to be purchased from CHP by suppliers as well as purchase prices, but the quotas are limited and they in average only assure the purchase of electricity produced within 1500 h of CHP system operation per year. New investments in large-scale biomass-fired CHP systems and "efficient cogeneration units" are also stimulated by the secondary act to the Law on Heat, which sets a merit order of heat to be purchased by DH systems and favors these two technologies [39].

There is National support of investments is a part of Public Investment Program. This program is regularly developed in Lithuania with the aim to the consolidate use of budget resources for capital investment and raise their efficiency. Responsible for this Program is the Ministry of Finance. The voluminous own resources of energy utilities are used to fund projects implementation. The main multilateral donor for increasing energy efficiency of DH sector has been EU, using pre-accession funds and programmes. Major bilateral donors have been Denmark, Sweden. Part of DH utilities is rented for foreign companies e.g. Dalkia, France; Finland. The investments projects, the value of which is higher than the minimal value established by the NCCPE, must be approved by this Commission prior to their implementation. The organization having initiated the project provides the project to the NCCPE for approval together with the conclusion of the municipality. This provision does not apply to the municipalities, which coordinate the price of the district heat supply with suppliers on their own. Investments in the energy sector were largely co-financed by the EU through the structural funds. Lithuania is among the leaders in terms of absorption of EU structural funds.

In line with Article 11.3 of the Law on Energy, the NCCPE approves planned investments of energy undertakings engaged in activities with regulated prices. On 10 July 2009 the NCCPE approved a new Investment Appraisal and Approval Procedure for Energy Company under which energy companies engaged in activities with regulated prices shall coordinate planned investments into construction of new or development of the existing energy sites. This procedure has come into force since 1 January 2010. The purpose of the Procedure is to establish assessment criteria for investments planned by energy companies and principles and procedure of investment approval by the NCCPE. Investments made by energy companies shall be grouped as follows, by the original investment purpose: investments made under the Government-approved Measure Implementation Plan to implement energy priorities set in the National Energy Strategy, and ensure supply security and reliability; investments made into system development (including new customer connection); investments made to reconstruct the existing system; investments made to reconstruct, modernize, etc., the existing system.

Non-reform related factors have the most significant impact on investments in electricity generation. Since 2002 the investments in renewable energy sources were increasing in Lithuania because of policy measures to promote use of renewable. Under the directive 2001/77/EC of European Parliament and Council of 27 of September 2001 on the Promotion of the Electricity produced from Renewable Energy Sources in the International Electricity Market Lithuania has obligated that in 2010 the electricity produced from alternative energy sources will make 7% of the total consumed amount.

Implementing the directive 2003/30/EC of the European Parliament and the Council on the Promotion of the Use of Biofuels or other Renewable Fuels for Transport Lithuania has obligated that by 2010 the share of biofuels in the market of petrol and diesel for transport purposes will account for 5.75%. Under the new directive of 2008 of the European Parliament and the Council on the Promotion of Use of Energy from Renewable Energy Resources, in 2020 Lithuania must meet the requirements that the share of energy from renewable energy resources must account for 23% in the amount of final energy consumed, and the share of biofuel must account for 10% in the balance of fuel for transport.

In order to promote the production and consumption of biofuel in Lithuania, on 18 July 2000 the Seimas of the Republic of Lithuania adopted the Law on Biofuel. On 5 February 2004 this law was amended according to the provisions of Directive 2003/20/EC of the European Parliament and the Council on Biofuel Utilisation in Transport and new edition was called the Law on Biofuel, Biofuels for Transport and Bio-Oils.

The Government of the Republic of Lithuania undertaking the EU Directive 2001//77/EC on 5 December 2001 by the Resolution No. 1474 approved The Rules for the Promotion of Production and Purchase of Electricity Produced from Renewable and Waste Energy Resources. On 18 September 2006 by the Resolution No. 897 the Rules were amended. According to this document is promoted the production of electricity produced by wind generators, biomass

plants, solar power generators and hydro power plants with the capacity of up to 10 MW as well as the purchase of it. The following promotion measures are applied: (1) Power plants are connected to the energetic grid according to the legislation with a discount of 40% of the interconnection fee for the producers. This discount is reckoned in public procurement of services and is compensated next year. (2) The electricity produced from renewable energy resources is purchased under the tariffs set by the National Control Commission for Prices and Energy. The purchase price of electricity produced from renewable energy resources until 2020 is higher than the market price. From 1 April 2002 until 1 January 2009 the price of the electricity produced consuming biofuel and by small scale hydro power plants was 0.20 LTL/kW h, and the price of the electricity generated by wind power generators was 0.22 LTL/kW h (average purchase price of electricity 0.09 LTL/kW h). Since 1 January 2009 these prices have changed: the price of the electricity produced consuming biofuel and by wind generators is 0.30 LTL/kW h, and that produced by hydro power plants is 0.26 LTL/kW.

Up to 2004 in Lithuania the main kinds of renewable energy resources were wood and hydro power while the utilisation of other resources was just at the beginning. In these latter years the generation of wind energy and production of biofuel have been rapidly developing. In Lithuania the utilisation of biomass (wood, forest cutting residues, straw, energetic plants, etc.) as well as hydro power resources is being developed [40]. There are constructed demonstrational geothermal and solar power plants, started the production of gas emitted from municipal waste dumps, expanded the amounts of biogas production (Table 5).

The economic and environmental impact of GHG emission trading in Lithuania was negligible. In the first trading period in Lithuania just 3 installations from total 93 installations included in GHG emission trading scheme emitted into atmosphere more GHG emissions than allocated EUA for them. Lithuanian enterprises treated GHG emission trading scheme as the form of EU subsidy to Lithuanian enterprises instead of obligation to reduce GHG emissions and did not share profit with consumers received from sold EUA neither used this money for GHG emission abatement. The audit carried by State Control indicated that just 12.3% of revenues generated from sold surplus of EUAs were used for pollution abatement in Lithuania. Just 14 mill. Lt from 118 mill Lt revenues from sold EUA in Lithuania were used for GHG emission reduction by Lithuanian enterprises. 84 mill. Lt is being kept on enterprises accounts and there is no clear evidence that these revenues will be used for pollution abatement [41]. During the study conducted by Lithuanian State Control it was detected that it is not established as to which purpose the income of enterprises received for the sold allowances should be used, therefore there was a risk in Lithuania that these funds may be used not for reduction of air pollution, but for other purposes. Based on recommendations of State Control Lithuanian parliament in 2009 has adopted the Law on Climate change management financial instruments where requirement for installations participating in GHG emission trading are set to use some percent of received income from sold allowances for GHG emission reduction measures and implement new energy efficient technologies and switch to renewables.

Lithuanian energy policy aims to ensure secure electricity supply at the lowest possible price for consumers and lowest possible impact on environment. State policy in electricity sector promotes use of renewable energy sources and construction of new nuclear power plant. The established mechanisms to support renewables had positive impact on investments in renewable based electricity generation.

7.2. Poland

The generation capacity in Poland is old and modernisation and maintenance investments have been insufficient until recently: more than half of the current capacity was built in the 1970s. Approximately 60% of the system is more than 15 years old, and 40% is more than 20 years old. More than 1.5 GW have been in operation for more than 30 years [19].

Power generation in Poland is completely dominated by coal (Poland ranks seventh in the world in total coal reserves). However, because of current and future international obligations to reduce CO_2 emissions, it is foreseeable that the use of coal will become more and more expensive [34]. But the energy policy in Poland assumes the fuel mix should remain about the same due to large resources of solid fuels (coal and lignite) lasting for up to 50 years. Furthermore, coal mines remain profitable in Poland thanks to staff costs that are still significantly below the E-15 levels. In 2004, Poland mined 99.2 million tons of hard coal, which is more than the total production of the EU-15 [16].

According to plans of the Polish government, the future development of the energy mix in Poland will be greatly influenced by the introduction of nuclear power. There is no nuclear power plant in Poland. The nuclear power project launched by the city of Gdansk in 1982 was stopped by the government in 1990 [16]. This process has already started and the first nuclear plant is expected to be connected by the end of 2020. The ecological policy of the EU is very challenging for the Polish Power sector and disconcerting for investor′s, specifically the requirements to abate emission of GHGs without promoting nuclear power plants as CO_2 free sources. However, the Government of Poland plans to move forward with its nuclear program, with expected commissioning dates around year 2020–2022 [5].

Investments (construction) of the first NPP to be executed in four stages: (1) until 31 December 2010—final date for adopting the Nuclear Power Programe for Poland by the Council of Ministers; (2) from 1 January 2011 until 31 December 2013—final site selection and conclusion of the contract for the construction of the first NPP; (3) from 1 January 2014 until 31 December 2015—technical design and obtaining all required decisions and permits; (4) from 1 January 2016 until 31 December 2020—construction of the first unit in the first NPP [42].

Poland depends on coal for 95% of its electricity production. According to the new EU Directive, Poland needs 15% of its final energy consumption to come from renewable energy by 2020, up from 7.2% in 2005. To date, the country has renewable energy production from biomass, biogas, wind and hydropower [43]. Poland is well suited for large scale wind power development. Average wind speeds between 5.5 and 7.0 m/s (at 50 m height) in large areas of

Table 5
Development of renewable capacities in Lithuania 2000–2010.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total solar capacity, kW	0.1	0.1	0.2	0.4	2	2.7	9	10	30	50	60
Total biogas capacity, MW	1.25	1.21	1.21	2.14	1.96	2.71	2.71	3.04	4.24	4.5	4.7
Total wind capacity, MW	–	–	0.16	0.16	0.85	1.1	48.1	52.3	54.4	62.8	92
Total small HPP capacity, MW	13.1	13.4	16.5	18.3	19.6	23.5	24.4	24.7	25.0	26	27

the country make Poland one of the most promising wind energy markets in Europe.

The Government of the Republic of Poland has direct impact on investments in generation technologies. In 2000, the Polish government introduced a power purchase obligation for renewable energy sources, which was first amended in 2003, and again in August 2008. This requires energy suppliers to provide a certain minimum share of power generated by renewable sources (from 3.1% in 2005 up to 10.4% in 2010 and 12.9% in 2017). In 2005, the Polish Law on Energy (1997) was amended to introduce an obligation for all renewable energy producers, regardless of the size of the installations, to obtain a license from the Energy Regulation Authority. Following this new requirement, more than 600 producers of renewable energy applied for and received licenses for producing electricity from renewable sources. In January 2010, the Polish Sejm (lower house of Parliament) approved a new act amending the Energy Law, and most of the changes came into force in March 2010. The main provisions of this amendment concern electricity trading, grid connection agreements and related charges, agricultural biogas and new tools and rules to enable the transmission system operator (TSO) to secure the electricity supply.

According to the Polish National Renewable Energy Action Plan gross final electricity consumption will rise from 150,027 GW h in 2010 to 202,362 GW h in 2020, despite of the efforts to increase energy efficiency. RES generation is forecasted to grow from 10,618 GW h in 2010 to 32,400 GW h in 2020; that means a total growth of 205% in a period of ten years [44]. The share of RES generation in gross final electricity consumption is expected to increase from 7.08% in 2010 to 16.01% in 2020 [45].

Wind is the fastest growing renewable energy source in Poland (Table 6) and it is expected to contribute about half of the renewable electricity required to reach the 2020 target. The pace of development of the wind energy sector in Poland has accelerated in recent years. Poland has some of the best wind resources in Central and Eastern Europe with areas reaching up to 1000 W/m^2 in power density. The latest Ernst & Young "Renewable energy country attractiveness index" ranks Poland as having the 10th most attractive wind market in the world. From 2005 to 2010 an increase in the production of electricity in wind power installations was observed, from 135 GW h to 1810 GW h, and installed capacities in wind farms grew over 14 times (from 83.3 MW to 1180.3 MW). Despite the existing barriers, companies investing in wind in Poland have successfully created ways of overcoming market obstacles, and the country is attracting significant foreign investment [46].

The Polish RES supports mechanisms have the direct impact on investments in electricity sector. Based on the number of applications received by the ERO for issuing licenses for wind farms, a big increase in wind generating capacity is expected in the near future. In the period up to 2013, support schemes currently available to investors, including EU cohesion and structural funds will help drive wind power growth. However, the most rapid increase is predicted between 2014 and 2020, when even more significant financing will become available from the EU funds, in particular from structural funds. According the Polish Wind Energy Association, 13 GW of wind energy could be installed in Poland by 2020 [46]. Wind power is the only renewable energy technology in Poland ready to attract significant investment, and there is a substantial pipeline of large wind farms spread evenly over the area of the entire country. These projects could be commissioned relatively soon and will make an important contribution to meeting Poland's target mandated by the new EU Renewable Energy Directive.

Regarding renewable energy projects, new provisions were introduced in regards to advance payments on interconnection fees. In addition, entities seeking grid connection now have to prove their ability to develop new generation capacity, which could put wind farm developers at a disadvantage, and there are fears that this new instrument could form a barrier to investment of wind energy [28].

Wind energy is leading in terms of value of capacity of new facilities (over 1000 MW in 2010). As far as construction of new wind farms is concerned, Pomeranian region in the leader. Another important source of clean energy in Poland is biomass energy. Biomass and wind appear to be the most promising renewable energy resources for development in Poland (with an estimated potential of about 4000 MW – biomass, 13,000 MW – wind energy). Both liquid and solid biomass are considered to be the main sources of renewable energy in Poland, for both electricity and thermal energy production. Biomass technologies and supply sources are relatively mature, and the investment costs are lower than for other maturing renewable energy technologies [47].

As of 31 December 2010 there were 18 licensed biomass power plants (including power plants producing electricity from forest, agricultural, and garden waste—7, producing electricity from industrial wood-based and pulp and paper waste—6, and power plants producing energy from mixed biomass—5). Furthermore, there were 41 power plants using the co-incineration technology [36]. As compared to 2004, the installed capacities of electricity from that source increased by seven times (Table 6).

Investments in electricity production from those sources is expected to continue growing over the next few years, mainly as a result of an increase in distributed generation based on CHP. Waste biomass and biomass from energy crops should account for an increasing percentage of biomass used in the co-incineration process; accordingly, mechanisms have been introduced requiring biomass other than forestry biomass to be used for this technology [48]. This type of biomass should be used mainly in the timber, pulp/paper and wood board industries.

Another important source of clean energy in Poland is hydro energy. Out of total hydro energy the larger portion comes from large-scale hydro energy installations, however it is expected that the future of Polish hydro-power engineering will be determined by the development of small power stations [29].

As of 31 December 2010 there were 727 licensed hydroelectric power plants, including: flow-of-the-river plants up to 0.3 MW—578 installations, flow-of-the-river plants up to 1 MW—78, flow-of-the-river plants up to 5 MW—56, flow-of-the-river plants up to 10 MW—6, flow-of-the-river plants over 10 MW—6, and flow-of-the-river plants with pumped storage units—3 [36]. The main increase in capacity over the next few years is expected to take place at small hydropower plants. Given the lack of potential and environmental conditions, there are no plans to build new large hydropower plants in Poland.

Table 6
Development of renewable capacities in Poland 2002–2010, MW.
Sources: [27,28,34,36].

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total biomass capacity	1	17	52	190	239	255	232	253	356
Total biogas capacity	15	18	22	33	36	46	55	71	83
Total wind capacity	59	60	65	83	153	288	451	725	1180
Total small ($<$ 10 MW) HPP capacity	210	236	243	258	262	262	269	273	280

The construction of new large hydroelectric power plants in Poland is difficult due to significant investment expenditure required for such projects, and due to environmental conditions. Polish hydropower resources are limited. Still, note that the share of hydroelectricity is decreasing, which is related to the dynamic development of other RES (including particularly wind installations and biomass power plants).

As Poland has limited hydropower and geothermal potential, wind power, biogas and biomass are expected to be the primary sources of new renewable energy. The most important objectives of Poland′s energy policy are to ensure a reliable supply of fuels and energy, strengthen economic competitiveness and minimise the harmful effects of the energy sector on the environment. One of the elements contributing to the achievement of these priorities is an increase in the use of renewable energy sources, which results in a decrease in the Polish economy′s dependence on imported energy carriers and reduces air pollution by preventing emissions of pollutants that are produced when conventional energy carriers are used.

8. Conclusions

The liberalization of electricity market in Lithuania and Poland was implemented because of EU requirements since 2001. Though Lithuania and Poland are neighboring countries there are no interconnections between these countries. The countries continue to implement joint energy projects, i.e., LitPollink, the Lithuanian-Polish power interconnection, is expected to be operational by 2015, also a gas interconnection between Poland and Lithuania will integrate the Baltic gas pipes into the EU gas pipeline system. In 2015 it is expected that Lithuanian electricity market will be integrated with Nordic and Continental Europe electricity markets.

The prices of electricity in Lithuanian PEX and Continental Europe electricity markets including Poland are quite similar. In 2012 January the average electricity prices in Lithuania PEX was 153.4 LT/MW h and in Poland –133.3 LT/MW h. In summer the prices of electricity were decreasing in both countries. The prices are strongly affected by the weather: when the temperature increase, the prices increase as more electricity is required for cooling, whereas generation at hydropower plants is also reduced. The wind also have impact on electricity prices because of increasing wind power generation.

The Lithuania and Poland have strong policies to promote RES because of implementation of EU directives targeting renewable and this policy had impact on increase of renewable capacities in both countries.

There was no impact of electricity market on investments in energy sector in Lithuanian and Poland because there was no real competition on the electricity market until 2010. There were no new generation capacities built since 1990 in Lithuania except small industrial CHP and renewables, mainly wind because of policy tools: feed-in tariffs, financial mechanisms, GHG emission trading scheme.

The similar situation is in Poland. The Polish policy to promote renewable includes the following mechanisms: Tradable Certificates of Origin; The Obligation for Power Purchase from Renewable Sources; an excise tax exemption on RES; the transportation priority for electricity from RES in transmission network.

With electricity market opening and establishment of PEX there is a real competition on electricity markets in both countries. At present the electricity market in Poland consists of three segments: bilateral contracts between the sellers (producers or trading companies) and consumers; transactions on the Energy Commodity Exchange and on electricity trading platforms; and balancing market, managed by the transmission system operator. The Poland electricity market structure and ownership has not had any impact on the potential investors′ decisions. Any further ownership unbundling on the distribution level which would weaken the economic terms for new investments in the sector.

EU environmental policy is a great challenge for the Polish power sector because of coal dominating in energy supply and disconcerting for investor′s, specifically the requirements to abate emission of GHGs without promoting nuclear power plants as CO_2 free sources. However, the Government of Poland plans to move forward with its nuclear program, with expected commissioning dates around year 2020–2022.

Non-reform related factors have the most significant impact on investments in electricity generation in Lithuanian and Poland. Since 2002 the investments in renewable energy sources have increased in Lithuania and Poland because of policy measures to promote use of renewable but not because of electricity market opening. The research was funded by a grant (No. IEP-01/2012) from Research Council of Lithuania.

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